# Course Objectives

1. To impart a broad knowledge of experimental methods and measurement techniques.
2. Study the sensors, transducers, and methods used to take accurate measurements of physical phenomena from the engineering point of view.
3. Analysis and Evaluation of measuring errors.
4. understanding of basic data acquisition and signal conditioning techniques.
5. Discussion of large number of instruments from standpoint of both theory of operation and specific function characteristics.
6. Selection of appropriate measuring instrument.

# Method of Evaluation

| | | |
|---|---|---|
| 1. | Laboratory | 3.33% |
| 2. | Sheets and reports | 3.33% |
| 3. | Application | 6.67% |
| 4. | Mid-term Exam | 6.67% |
| 5. | Oral Exam | 20% |
| 6. | Final-term Exam | 60% |


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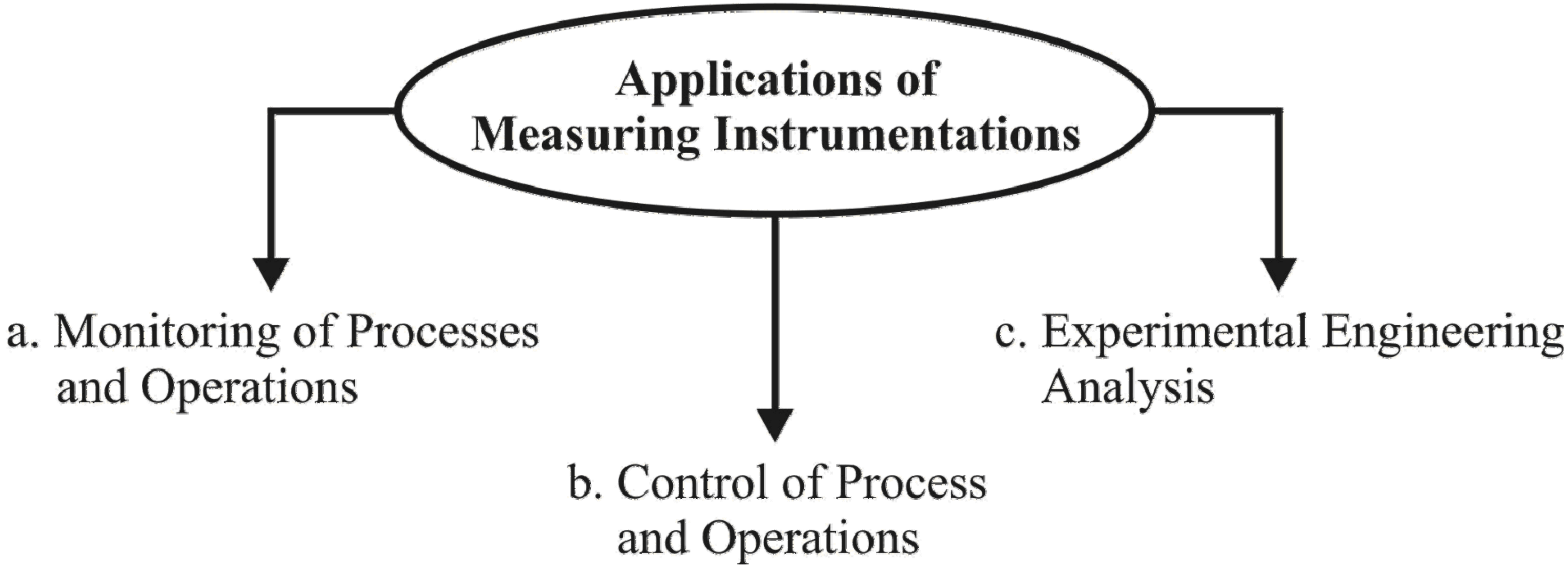
# Application of Measurement Instrumentation (1)



# Application of Measurement Instrumentation (2)

## a. Monitoring of processes and operations

1. Thermometers, barometers used by the weather bureau.
2. Water, gas and electric meters in the home.
3. Different dials in the front panel of the car





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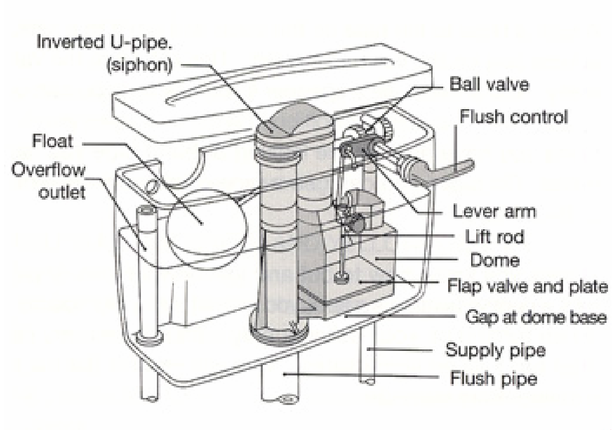
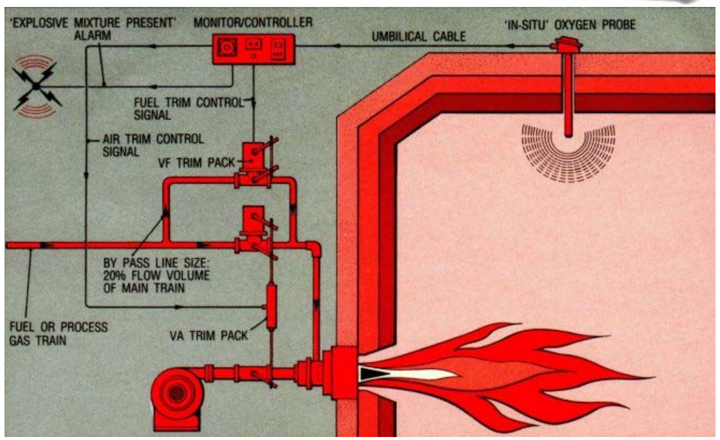
# Application of Measurement Instrumentation (3)

## b. Control of processes and operations

1. Home air condition
2. Missile control
3. The fridge
4. Furnace control
5. Cistern



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# Application of Measurement Instrumentation (4)

## c. Experimental engineering analysis

| Theoretical methods | Experimental methods |
|---|---|
| Often give results that are general use. | Results are often restricted to specific system (dimensional analysis may allow some generalization). |
| Required the application of simplifying assumptions (mathematical models). | No simplifying assumption .the true behavior of the system is revealed. |
| May lead to complicated mathematical problems. | Accurate measurements necessary to give a true picture. |
| Only pencil, paper, computing machines, etc. are required. | Actual system or a scale model is required. |
| No time delay engaged in building models, assembling and checking instrumentation and gathering data. | Considerable time required for design and construction of apparatus. |


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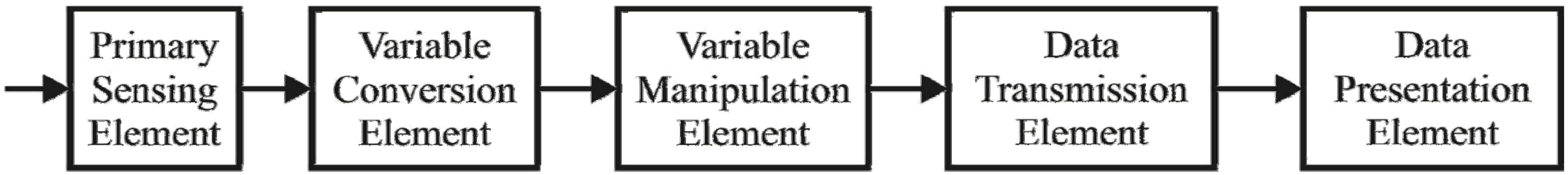
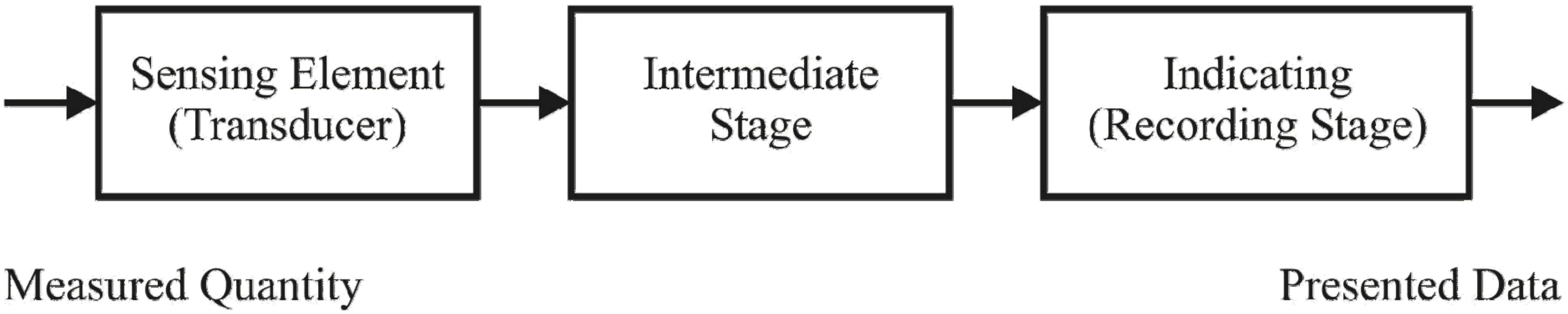
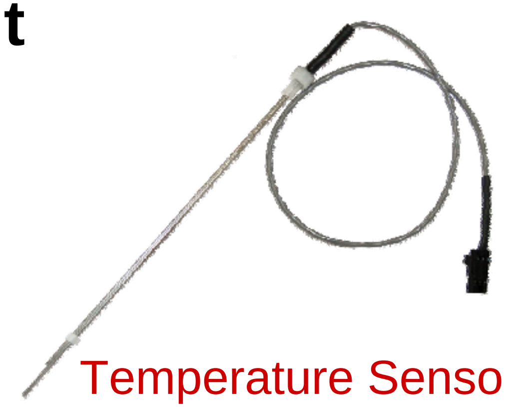
# Functional Elements of an Instrument



# Primary Sensing Element



Temperature Sensor

- sometimes called pickup, sensor, or transducer.
- It detects the physical variable to be measured, e.g. pressure, temperature, rate of flow, etc. and converts the signal into amore usable form.
- In practice the physical variable is usually transformed into a mechanical or an electrical signal.


Pressure Sensor

Oxygen Sensor



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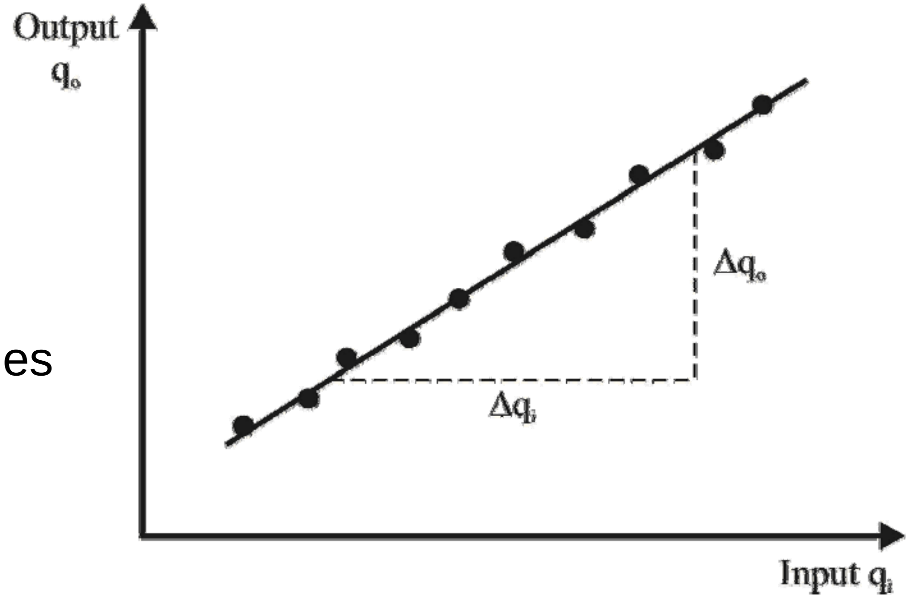
# Basic Requirements of Transducer (1)

**Ruggedness**:

Ability of transducer to withstand over load; i.e. high mechanical and thermal stresses.

**Linearity**:

Ability of transducer to produce an output signal which varies linearly with the changes of the measured quantity.




**Repeatability**:

Ability of transducer to reproduce an output signal exactly when the same measured quantity is applied repeatedly under the same environmental conditions.

# Basic Requirements of Transducer (2)

**High stability and reliability**:

Minimum errors in measurement, unaffected by temperature, vibration and other environment variations

**Convenient instrumentation**:

The transducer should produce sufficiently high output signal with high signal-to-noise ratio. This will reduce the elements of signal conditioning and so makes easy the recording of signal.

**Good dynamic response**:

Ability of transducer to follow the dynamic variations in the measured quantity.

# Active and Passive Transducers

**Active Transducers**:

The output energy of Active Transducers is supplied entirety or almost entirety by its input signal.

Thermocouple (Active Transducer)

**Passive Transducers**:

Have an auxiliary source of power. This power source is necessary for the operation of passive transducers.

Mic (Passive Transducer)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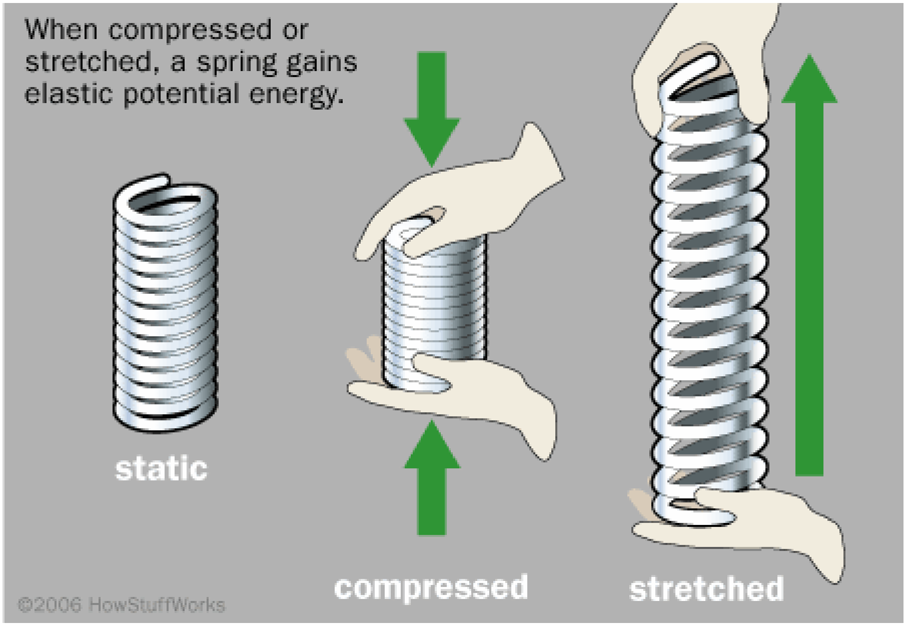
# The Variable Conversion Element

Converts a measured variable from one form to another more suitable form




For example: spring is some times included to convert an applied force or torque to a linear or angular displacement.

# The Variable Manipulation Element

Variable manipulation means a change in numerical value according to some definite rule but preservation of the physical nature of the variable.


For example: electronic amplifiers and gears.

# Data Transmission Element

transmit the data from one element to another .


For example: electrical cables and connecting rods.

# Data Presentation Element

For monitoring, control or analysis purposes the measured quantity must be put into a form recognizable by one of the human senses.



Indicating instruments

Recording instruments



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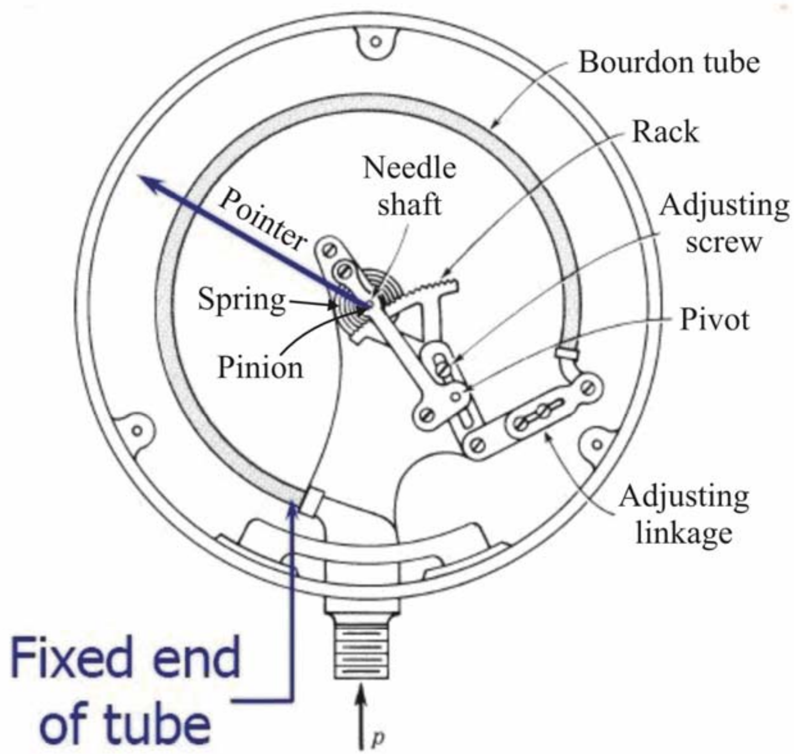
# Example: Bourdon tube pressure gauge





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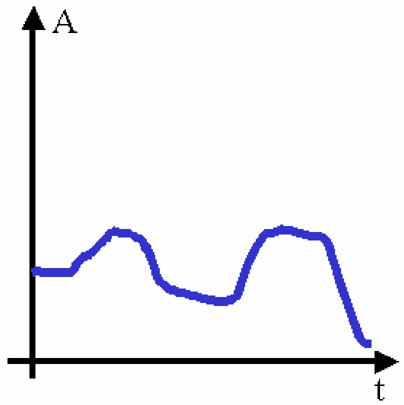
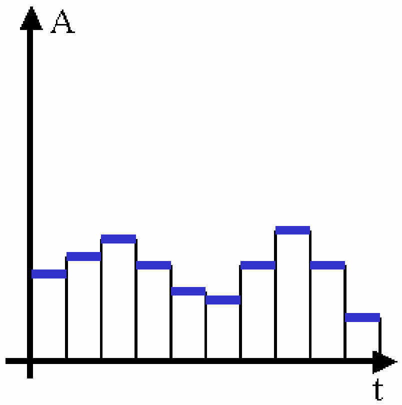
# Analog and Digital Modes of Operation

- ❑ Analog signals are those which vary in a continuous fashion and can take on infinity of values in any given range

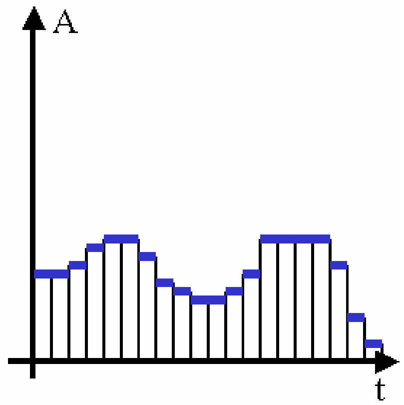
- ❑ Digital signals vary in discrete steps and can thus take only a finite number of different values in any given range



Analog signal – continuously varying



Digital signal – large time divisions



Digital signal – small time divisions



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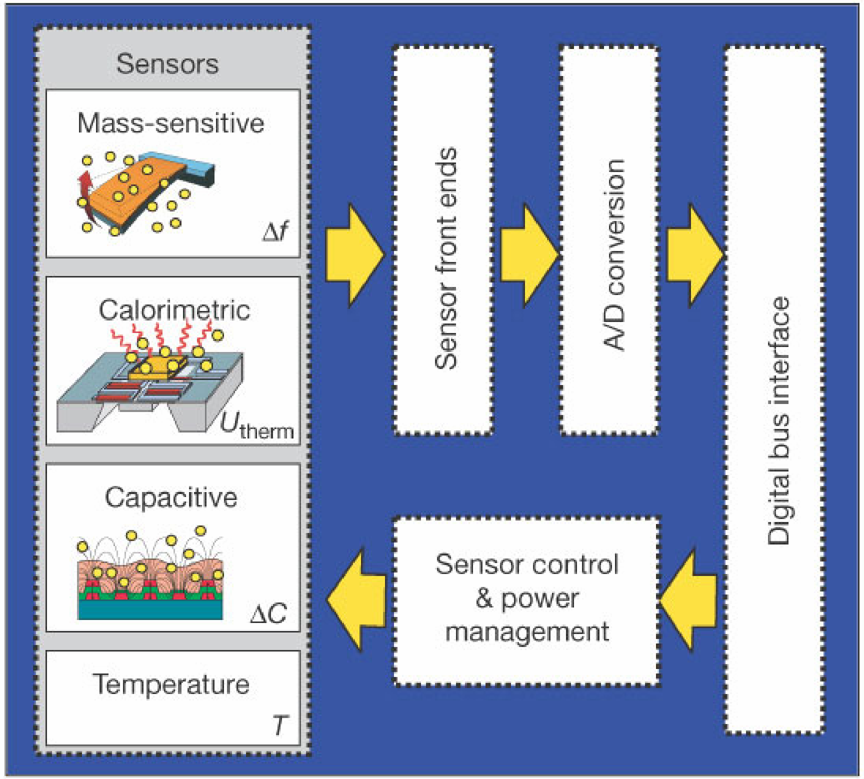
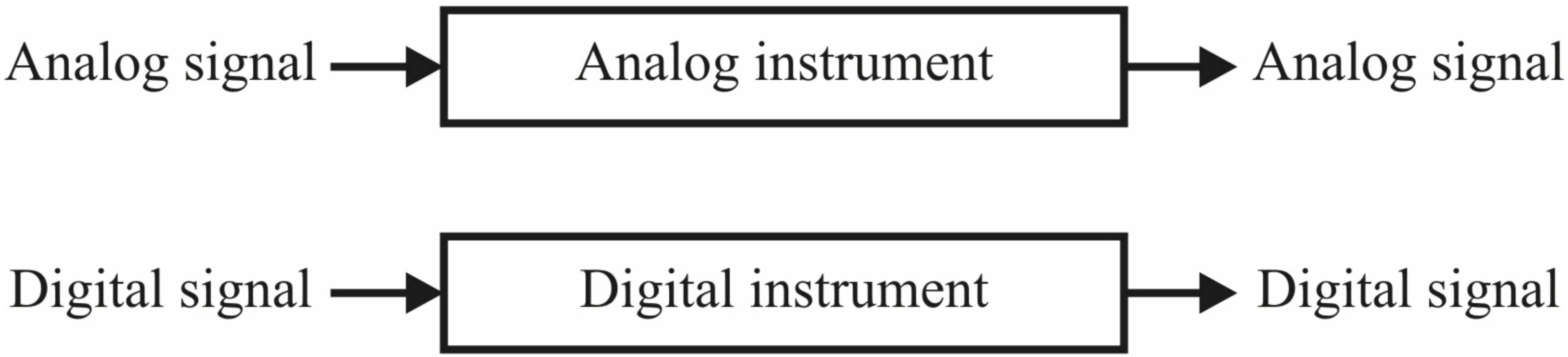
## Analog to Digital (A/D) and Digital to Analog (D/A) Converters

- A/D and D/A converters serve as translators that enable the computer to communicate with the outside world (other instruments).

- Most physical variables, such as current, temperature, displacement, acceleration, speed, pressure, light intensity, and strain, tend to be continuous in nature and are readily measured by an analog sensor and represented by an analog signal.



# Analog and Digital Instruments




❑ A/D and D/A converters are used to convert from one form to another

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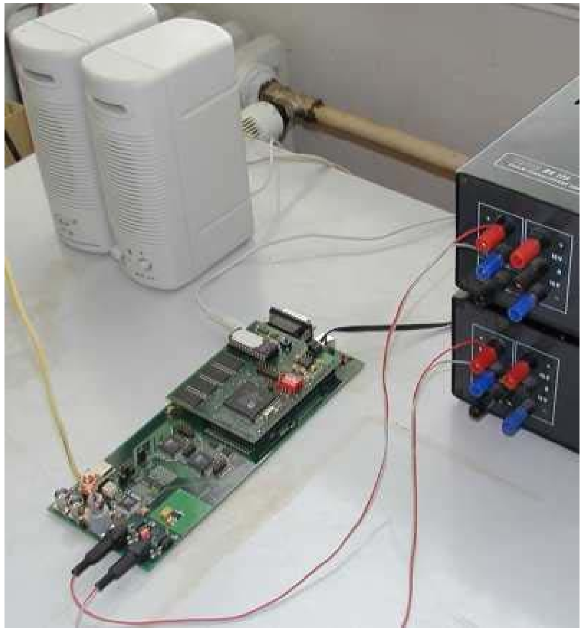
# Analog to Digital Converters


# Digital to Analog Converters

# Null and Deflection Instruments

**Defelction Instrument:**

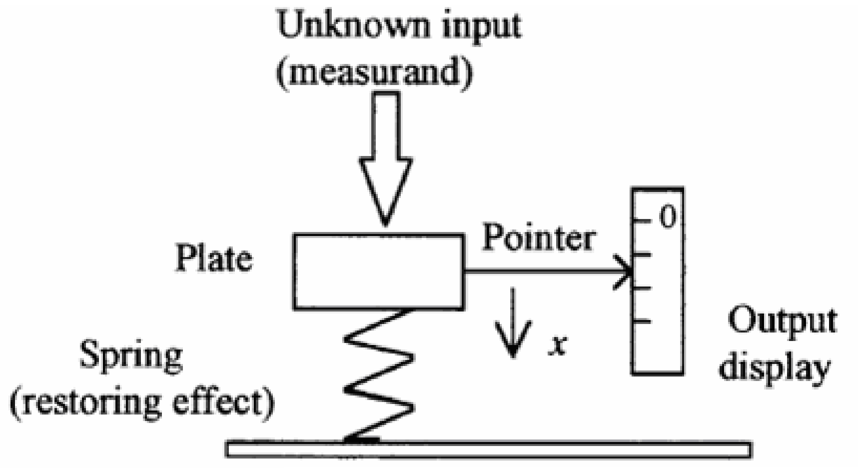
The Output reading is a deflection or a deviation from the initial condition of the instrument.

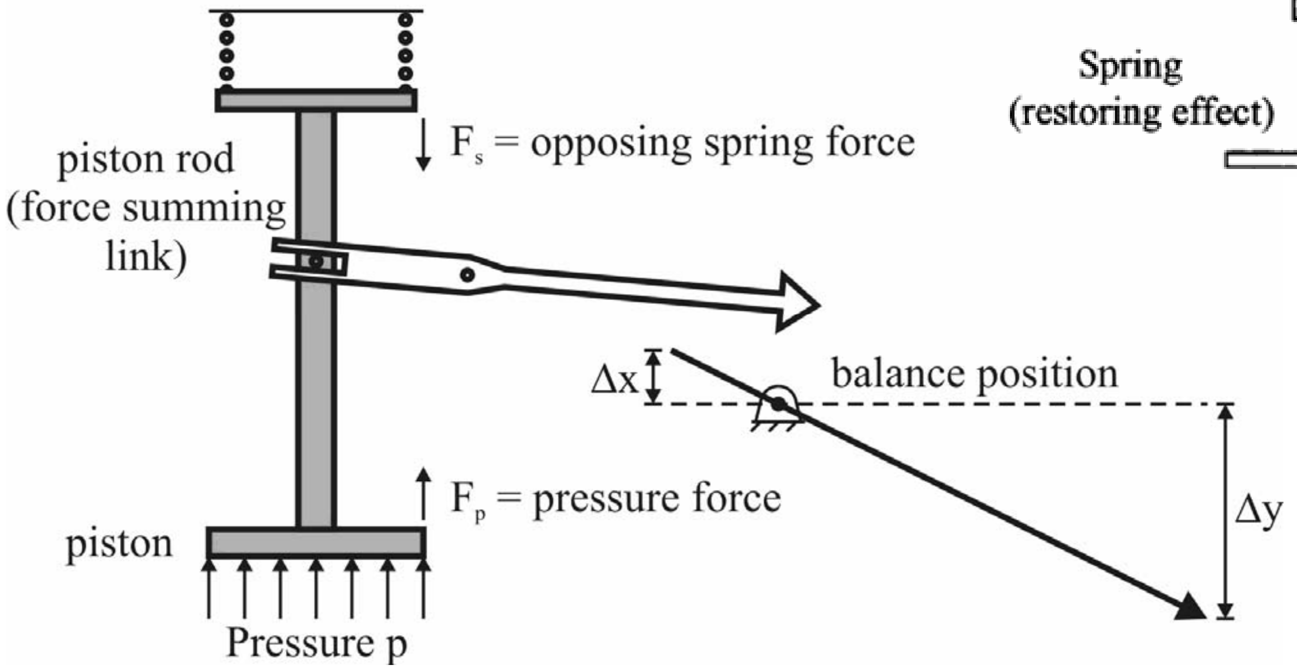
**Null Instrument:**

1. The instrument exerts an influence on the measured system so as to oppose the effect of the measured quantity.
2. The influence and the measured quantity are balanced until they are equal but opposite in value, yielding a null measurement.

# Examples of Deflection Instruments

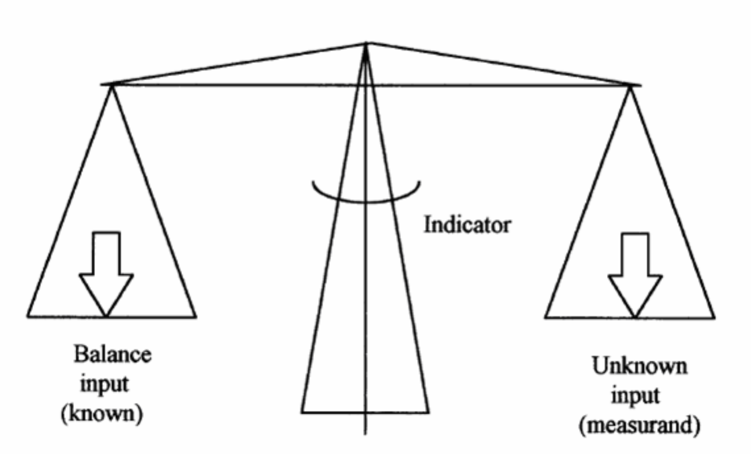
A deflection instrument has always deflection or deviation from intial condition during measurement

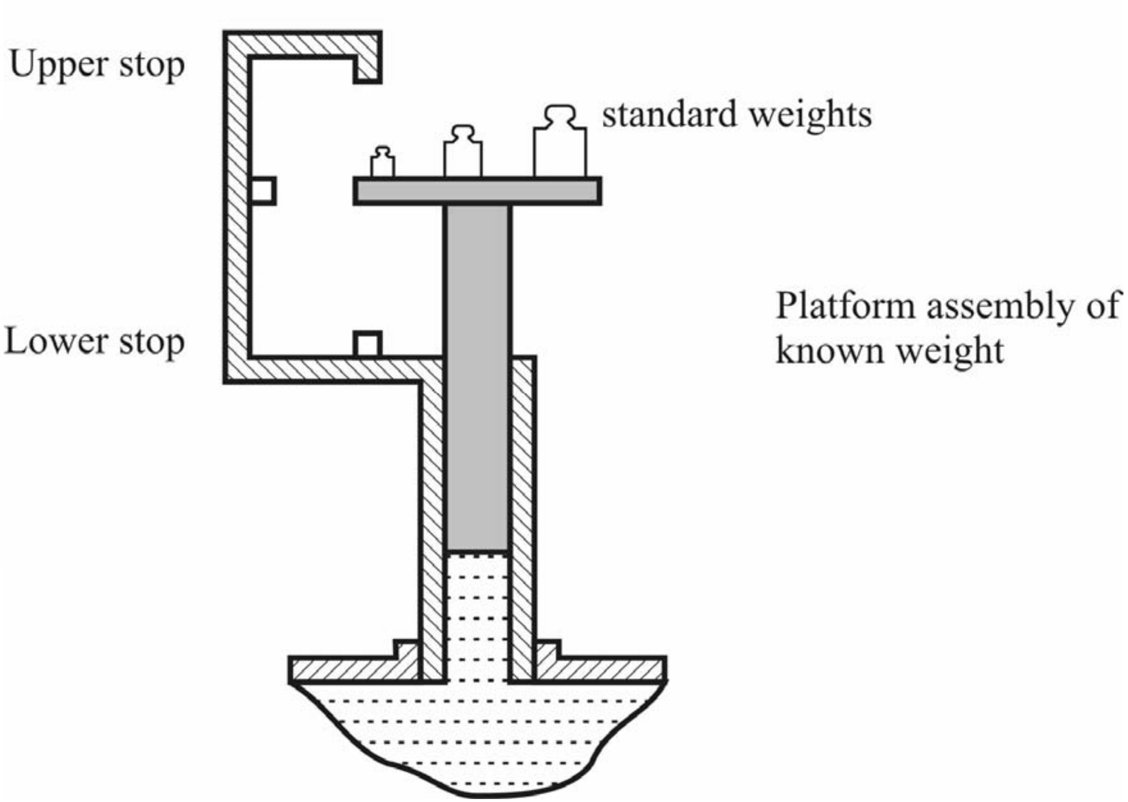


# Examples of Null Instruments

A null instrument has always **zero** deflection or deviation from intial condition during measurement



# Comparison between Null and Deflection Instruments

- The accuracy attainable by the null method is of higher level than that of deflection method.
- The null method is more sensitive than the deflection method.
- A deflection instrument must be a larger, more rugged, and thus less sensitive.
- The disadvantage of null methods appears mainly in the dynamic measurements.


Thank You!